disclosed in column 3, lines 26-45. The examiner further states that this reference does not disclose axial roll forming performed by pressing the first and second hollow cylindrical workpieces against each other between two diametrically opposed outer roll forming tools and an inner rolling arbor or between two diametrically opposed outer roll forming tools and an inner roll forming tool.

Examiner refers to *Hopkins* as teaching roll forming a clad tubing by inserting a mandrel 43 into a subassembly made of two hollow cylindrical workpieces 26 and 27 and roll forming a clad tube by using two diametrically opposed rolls 42 to metallically bond the workpieces, the workpieces 26 and 27 being deformed radially and axially as disclosed in column 1 of page 4, lines 42-46, and in Fig. 9. In examiner's opinion, it would have been obvious to use the two diametrically opposed rolls and the inner mandrel as disclosed in *Hopkins* for axial roll forming as disclosed in *Chalansonnet* in view of the teachings of *Hopkins* in order to achieve excellent metallic bond between the workpieces. Examiner notes that it would be inherent to have play to be able to insert the two workpieces into one another (*Chalansonnet*) and that the benefit disclosed in *Chalansonnet* would work for workpieces with or without radial play.

Chalansonnet (US 4,189,816) is the equivalent of *DE 2745527* discussed in the instant specification. *Chalansonnet* discloses the manufacture of a bearing race from two blanks 5 and 6 by cold rolling, as set forth in col. 3, lines 9-45:

"The method of fabricating the bearing race is as follows: the outer ring 2 is realized starting from a blank 5 (FIG. 3) by a known technique using the operations of turning or punching. The outer diameter A and the width C of the blank 5 are slightly less than the outer diameter B and the width D of the ring 2, respectively. The diameter E of the hole through the blank is slightly less than the outer diameter F of the blank 6 for the inner ring 1.

The blank 6, shown in FIG. 4, made of bearing steel of type 100 c6 can likewise be formed by turning or punching or by rolling strips into rings and welding them together. The width K of the blank 6 is slightly less than the width C of the blank 5 for the outer ring 2. On the other hand, its outer diameter F is slightly greater than the diameter E of the hole in the blank 5.

The two blanks 5 and 6 are then mated in the press, one inside the other as shown in FIG. 5, and the faces of the inner blank 6 are at equal distances from those of the outer blank 5.

The dimensional proportions between the two blanks 5 and 6 are chosen so as to make the sum of their weights equal to that of the composite race.

The two blanks, assembled concentrically, then form a unit which is to be deformed radially. The rolling operation as shown in FIGS. 6 and 7 is performed while the outer blank 5 is confined in a support made up of two separable shells 7 and 8, the inner dimensions of which are equal to the outer diameter B and the thickness D of the race being made. A suitably shaped roller 9 of profile corresponding to that of the ball grooves is driven in rotation and in translation towards the blank **6. In the course of the rolling process the blanks 5 and 6, under the action of the pressure exerted by the roller 9, deform axially and radially** until they completely fill a cavity 10 in the support bounded by the separable shells 7 and 8. "

Thus, in essence, two annular blanks are pressed into one another (the outer diameter of the inner ring is greater than the inner diameter of the outer ring) and the unit of press-fit rings is then cold rolled in a **stationary outer mold 7, 8** by roller 9 that exerts pressure onto the inner ring and slowly deforms the rings as shown in Figs. 6, 7. The radial pressure causes axial and radial deformation as shown in Fig. 6 (before) and Fig. 7 (after). No diametrically opposed outer roll forming tools interacting with an inner rolling arbor or two diametrically opposed outer roll forming tools interacting with an inner roll forming tool are disclosed. As discussed in the instant specification, paragraph bridging pages 1 and 2, this prior art method is flawed as the bond between the rings is unsatisfactory.

Hopkins relates to an entirely different process. *Hopkins* discloses a method for producing seamless pipes by hot rolling in accordance with the Mannesmann process. The tube material is comprised of an annulus of a first material and a cast second material in order to produce clad pipes. Examiner refers to Fig. 9 and also the text portion on page 4, left column, lines 42-46, where according to the examiner rollers 42 are shown that are diametrically opposed to one another. However, this text portion discloses nothing in regard to bonding the two materials and only sets forth that the rolling process produces diameter expansion and thickness reduction of the pipe blank (billet):

"The pierced or opened billets are then passed through one or more rolling mills that include a pair of rolls 42 which cooperate with mandrels 43 to reduce their thickness and diameter and elongate them into tubes."

Hopkins - as set forth on page 1, lines 1-6, of the left column - relates to *"the manufacture of composite seamless metallic tubes and in particular to the manufacture of seamless tubes having an integral lining of special characteristics inseparably and continuously bonded to the main body of the tube."*

The composite seamless tube comprising a stainless steel annulus and a thin seamless annulus of chrome-containing alloy bonded to the steel annulus throughout the interfacial area is produced by first casting a steel ingot 20, reducing the ingot 20 to a billet 22 by means of rolls 21, and the billet 22 is then pierced by any desired operation such as drilling, punching, etc. or by passing the billet through a Mannesmann mill as shown in Figs. 4 and 5. The resulting steel annulus 26 has bore 25 (see page 2, right column, lines 34ff, in regard to the preparatory steps). This steel annulus 26 is used to prepare a composite billet 27 by filling the bore 25 with a core 28 of chromium-containing alloy by casting molten alloy, as shown in Fig. 6, or by filling the central bore 25 by using an apparatus as shown in Fig. 7, employing electric arc deposition. The result is the composite billet 27 as shown in Fig. 8. The process of pouring or casting alloy into the bore 25 as well as the process of electric arc deposition both provide an intimate connection of the outer annulus and the inner core. Therefore, an intimate bond between the outer steel annulus and the inner chromium-containing alloy is already present in the composite billet 27.

The composite billets 27 with core 28 *"are then heated to a suitable temperature preparatory to forming them into tubes"* (page 4, lines 22-26), as e.g. by the Mannesmann mill process (see enclosed copy of "WIKIPEDIA - Rotary piercing" where the Mannesmann process is explained). As an alternative, the composite billet 27 can also be subjected to boring, drilling etc., as set forth in lines 36 to 41 of the left column of page 4, in order to produce the tube; this means material is cut or removed from the core with a thin inner cladding of the second material remaining and alloy material being removed.

The method of casting molten material into the steel annulus as well as the step of boring or drilling out the core for producing the tube are clear evidence that the composite billet 27 already has a metallic bond between the outer annulus and the inner core - no rolling step for producing an intimate metallic bond between the inner and outer layers is performed or suggested. Moreover, the Mannesmann mill process is a hot forming process and not a cold rolling process. Also, in the Mannesmann mill process the billet is forced axially through the roll/arbor arrangement.

Therefore, examiner's contention that the rolls used in the process of preparing the tube - as shown in Fig. 9 - are producing the metallic bond between the inner and outer layers finds no support in *Hopkins*, especially since the referenced text portion of page 4 (col. 1, lines 42 to 46) only refers to thickness reduction and diameter reduction and elongation of the tubes. Also, since the composite material 27 is forced or passed through the rollers and past the mandrel in axial direction, as shown in Fig. 9, axial and radial deformations and elongations occur. Producing tubing in a Mannesmann mill means that the billet is first heated and then passed lengthwise through the arrangement of rollers and mandrel as explained in connection with Figs. 4 and 5 (page 2, right column, lines 45-65). This set-up has nothing in common with and is not applicable to a cold rolling process.

Hopkins thus relates firstly to a composite material that is already intimately bonded and secondly to processing the composite material after having been heated to a suitable working temperature. Therefore, a person skilled in the art will not find a suggestion or motivation to use the *Hopkins* process relating to a composite material that is heated and processed in a Mannesmann mill to a cold rolling process as disclosed in *Chalansonnet*.

Reconsideration and withdrawal of the rejection of the claims under 35 USC 103 are respectfully requested.

CONCLUSION

In view of the foregoing, it is submitted that this application is now in condition for allowance and such allowance is respectfully solicited.

Should the Examiner have any further objections or suggestions, the

undersigned would appreciate a phone call or **e-mail** from the examiner to discuss appropriate amendments to place the application into condition for allowance.

Authorization is herewith given to charge any fees or any shortages in any fees required during prosecution of this application and not paid by other means to Patent and Trademark Office deposit account 50-1199.

Respectfully submitted on March 16, 2010,

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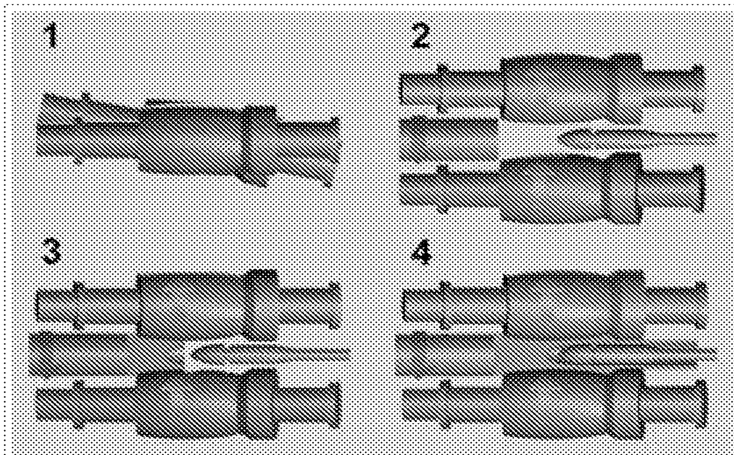
GEH
Encl.: WIKIPEDIA -Rotary piercing

Rotary piercing

From Wikipedia, the free encyclopedia

Rotary piercing is a hot working metalworking process for forming thick-walled seamless tubing. There are two types: the Mannesmann process and Stiefel process.

Mannesmann process



A schematic of rotary piercing. Key:
1. Roller configuration
2. The process starts with the blank fed in from the left.
3. The stresses induced by the rolls causes the center of the blank to fracture.
4. Finally, the rolls push the blank over the mandrel to form a uniform inner diameter.

A heated cylindrical billet is fed between two convex-tapered rollers, which are rotating in the same direction. The rollers are usually 6° askew from parallel with the billet's longitudinal axis. The rollers are on opposite sides of the billet and the surface of their largest cross sections are separated by a distance slightly smaller than the outer diameter (OD) of the original billet. The load imparted by the rollers compresses the material and the 6° skew provides both rotation and translation to the billet. The friction from between the rollers and the billet is intentionally high and many times increased with knurling of the rollers. This friction sets up stresses varying radially through the billet cross section with the highest stresses are at the OD and the central axis. The stress exceeds the yield strength of the billet and cause circumferential fissures to propagate at various radii near the OD and a central longitudinal void to form at the axis. A tapered mandrel is set inside and a short distance from the start of the central void. This mandrel forces the material outward and compresses the material against the back side of the tapered rollers. This compressive loading fuses the various circumferential fissures and sets the initial internal diameter and OD values. The newly formed tube is then cooled and can be cold worked to further refine the diameters and to gain the desired yield strengths.[1]

Mannesmann mills can produce tubes as large as 300 mm (12 in) in diameter.[1]

Stiefel process

The Stiefel process is very similar to the Mannesmann process, except that the convex rollers are replaced with large conical disks. This allows for larger tubes to be formed.[1]

References

1. ^ *a* *b* *c* Degarmo, E. Paul; Black, J T.; Kohser, Ronald A. (2003), *Materials and Processes in Manufacturing* (9th ed.), Wiley, p. 404, ISBN 0-471-65653-4.